REMARKS

Favorable reconsideration and allowance of the claims of the present application are respectfully requested.

Before addressing the specific grounds of rejection raised in the present Office Action, applicants have amended Claim 1 to positively recite that the relaxed $Si_{1-y}Ge_y$ epitaxial layer which is formed over the graded $Si_{1-x}Ge_x$ layer is one in which y, the germanium content of the relaxed $Si_{1-y}Ge_y$ epitaxial layer, is equal to or substantially equal to the value of x at an upper surface of the graded $Si_{1-x}Ge_x$ epitaxial layer. Support for this amendment to Claim 1 is found at Page 5, lines 24-25 of the specification of the instant application.

Applicants have also amended Claim 1 to positively recite that the metal silicide formed includes germanium. Support for this amendment to Claim 1 can be deduced from the fact that the intermediate agent layer is in contact, at one interface with the relaxed SiGe layer. During the silicidation process, as is known to those skilled in the art, the metal reacts with Si to form a metal silicide. Because the interface in question is between a SiGe layer and a metal, the metal silicide inherently includes germanium.

Applicants have also cancelled Claim 19, without prejudice.

Since the above amendments to the claims do not introduce new matter into the specification of the instant application, entry thereof is respectfully requested.

Claims 1, 9, 10, and 19 stand rejected under 35 U.S.C. § 103 as allegedly unpatentable over the combined disclosures of U.S. Patent No. 6,521,041 to Wu, et al. ("Wu, et al."), U.S. Patent No. 6,328,796 to Kub, et al. ("Kub '796") and U.S. Patent No. 4,826,787 to Muto, et al. ("Muto, et al."). Claim 6 stands rejected under 35 U.S.C. § 103 as allegedly unpatentable over the combined disclosures of Wu, et al., Kub '796, Muto, et al. and U.S. Patent No. 5,906,951 to Chu, et al. ("Chu, et al."). Claims 1, 9, 10, 19 and 21-23 stand rejected under 35 U.S.C. § 103 as

allegedly unpatentable over the combined disclosures of U.S. Patent No. 6,573,126 to Cheng, et al., Kub '796 and Muto, et al. Claim 22 stands rejected under 35 U.S.C. § 103 as allegedly unpatentable over the combined disclosures Cheng, et al., Kub '796, Muto, et al. and U.S. Patent No. 6,153,495 to Kub, et al. ("Kub '495").

Applicants submit that the combinations of applied references that utilize Wu, et al. as the principal reference do not render applicants' claimed method obvious since none of the applied references teaches or suggests the various processing steps claimed. Specifically, the applied references do not teach or suggest a method which includes the steps of forming a graded $Si_{1-x}Ge_x$ epitaxial layer on a first single crystalline semiconductor substrate, forming a relaxed $Si_{1-y}Ge_y$ epitaxial layer over said graded $Si_{1-x}Ge_x$ layer, *wherein y, the germanium content of the relaxed $Si_{1-y}Ge_y$ epitaxial layer, is equal to or substantially equal to the value of x at an upper surface of the graded $Si_{1-x}Ge_x$ epitaxial layer*, smoothing the surface of said relaxed $Si_{1-y}Ge_y$ epitaxial layer to provide a surface roughness in the range from about 0.3 nm to about 1 nm root mean square (RMS), selecting a structure having an upper surface and comprising a second substrate having a surface roughness in the range from about 0.3 nm to about 1 nm RMS and an intermediate agent layer comprising a metal selected from the group consisting of W, Co Ti and any other metal that can react with silicon to form a metal silicide, and bonding said smoothed surface of said relaxed $Si_{1-y}Ge_y$ epitaxial layer on said first substrate to the upper surface of said structure including said second substrate, said step of bonding including the step of annealing to form sufficiently strong bonds across the bonding interface to form a single mechanical structure, whereby during said bonding said intermediate agent layer is converted into a *metal silicide which includes germanium.*

Wu, et al. describe a method in FIG. 10 in which a first structure including a Si substrate 1002, a SiGe graded layer, and a SiGe uniform layer is formed. A second structure including Si

substrate 1010 and SiO_2 layer 1012 is provided and thereafter the uniform SiGe layer is bonded to the SiO_2 layer of the second substrate by annealing. Wu, et al. do not teach or suggest that the second structure includes an intermediate agent layer comprising one of the metals recited in Claim 1 and that upon annealing the metal reacts with Si to form a silicide that includes germanium Applicants observe that the term "silicide" does not appear anywhere in the disclosure of Wu, et al.

Applicants further observe that in the present invention, the relaxed SiGe layer has a Ge content that is equal to or substantially equal to the Ge content within an upper layer of the graded SiGe layer. In contrast, Wu, et al. disclose that there is a jump in Ge concentration (5 atomic % or greater) between the graded SiGe layer and the overlying SiGe etch stop layer. See, for example, Col. 7, lines 5-45. Thus, Wu, et al. do not teach or suggest the feature of the claimed method in which a relaxed SiGe layer having a Ge content that is equal to or substantially equal to the underlying SiGe buffer layer is formed. Indeed, Wu, et al. teach away from the claimed method since the prior art requires a jump in the Ge content at the interface between the overlying SiGe layer and the buffer SiGe layer.

The above defects in Wu, et al. are not alleviated by Kub '796 since the secondary reference also does not teach or suggest the claimed method recited in amended Claim 1. In particular, Kub '796 does not teach or suggest that upon bonding the intermediate agent layer is converted into a metal silicide that includes Ge. Kub '796 does mention that a metal or a silicide layer may be present at the bonding interface, but there are no details in the reference as to how the layer is formed. Applicants observe that at Col. 7, lines 6-15, Kub '796 indicates that an additional layer, such as a silicide, can be provided between the two bonding surfaces. The additional layer is disclosed as being formed **prior to** bonding. See Col. 9, lines 35-45. Hence, a silicide process, including metal deposition and annealing, occurs prior to bonding. In the

claimed method, the silicide which includes Ge forms during the bonding step not prior, as disclosed in Kub '796.

Applicants observe that the Kub '796 does not mention that SiGe can be used in the disclosed method. Kub '796 does mention in the prior art Section that a heavily doped SiGe etch stop layer is known, but the disclosure of Kub '796 fails to teach or suggest the use of the same in the disclosed patent.

Applicants further observe that the Examiner appears to rely on Col. 4, line 35-37 for the disclosure that Kub '796 teaches an in-situ silicide process. This is incorrect. Instead, the identified text of Kub '796 teaches that "[M]aterials such as silicon and germanium that melt during a bonding process and react with the substrate material can be used to bond two SiC substrates together." This does not teach that a metal silicide can be formed since neither Si or Ge react with a SiC to form a silicide.

Muto, et al. do not alleviate the above defects in Wu, et al. and Kub '796 since the applied second reference also does not teach or suggest applicants' claimed method in which an intermediate agent layer is used and upon bonding forms a metal silicide containing germanium on the surface of a relaxed SiGe layer that has a Ge content that matches that found within an upper region of the underlying graded SiGe layer. Specifically, Muto, et al. do not teach or suggest SiGe layers, let alone the claimed relaxed SiGe layer that is located atop a graded SiGe layer. Moreover, the silicide formed in Muto, et al. does not include Ge, as presently recited for in the claims of the present application.

Chu, et al. which provide a method for forming strained layers on an insulator comprising the steps of: selecting a first semiconductor substrate, forming a first epitaxial graded layer of $Si_{1-y}Ge_y$ over said first semiconductor substrate where y at its upper surface is in the range from 0.2 to 0.5, forming a second relaxed layer of SiGe, forming a third p++ doped layer of SiGe,

forming a fourth epitaxial strained layer selected from the group consisting of Si and SiGe, forming a fifth relaxed $Si_{1-x}Ge_x$ layer where x is in the range from 0.2 to 0.5, forming a sixth layer of Si, selecting a second substrate having an upper layer selected from the group consisting of Si and SiO_2 thereon, bonding the upper surface of said sixth layer and said second substrate together, and removing said first substrate and said first and second layers, do not teach or suggest the claimed method recited in amended Claim 1. In particular, Chu, et al. do not teach or suggest that upon bonding an intermediate agent layer is converted into a silicide that includes Ge, as indicated in applicants' sequence of processing steps recited in Claim 1. Indeed, applicants find no reference to the term silicide in the Chu, et al. disclosure.

Based upon the above amendments and remarks, the obviousness rejections based on Wu, et al., Kub '976 and Muto, et al. or Wu, et al., Kub '976, Chu, et al. and Muto, et al. have been obviated. Reconsideration and withdrawal thereof are respectfully requested.

Applicants submit that the combinations of applied references that utilize Cheng, et al. as the principal reference do not render applicants' claimed method obvious since none of the applied references teaches or suggests the various processing steps claimed. Specifically, the applied references do not teach or suggest a method which includes a sequence of processing steps that results in the formation of a metal silicide that includes Ge atop a relaxed SiGe layer having a Ge content that is equal to (or substantially equal to) that found in the upper region of an underlying graded SiGe layer.

Cheng, et al. provide a method for producing monocrystalline semiconductor layers. In an exemplary embodiment, a graded $Si_{1-x}Ge_x$ (x increases from 0 to y) is deposited on a first silicon substrate, followed by deposition of a relaxed $Si_{1-y}Ge_y$ layer, a thin strained $Si_{1-z}Ge_z$ layer and another relaxed $Si_{1-y}Ge_y$ layer. Hydrogen ions are then introduced into the strained $Si_{1-z}Ge_z$ layer. The relaxed $Si_{1-y}Ge_y$ layer is bonded to a second oxidized substrate. An

annealing treatment splits the bonded pair at the strained Si layer, whereby the second relaxed $Si_{1-y}Ge_y$ layer remains on said second substrate. In another exemplary embodiment, a graded $Si_{1-x}Ge_x$ is deposited on a first silicon substrate, where the Ge concentration x is increased from 0 to 1. Then, a relaxed GaAs layer is deposited on the relaxed Ge buffer. As the lattice constant of GaAs is close to that of Ge, GaAs has high quality with limited dislocation defects. Hydrogen ions are introduced into the relaxed GaAs layer at the selected depth. The relaxed GaAs layer is bonded to a second oxidized substrate. An annealing treatment splits the bonded pair at the hydrogen ion rich layer, whereby the upper portion of relaxed GaAs layer remains on said second substrate.

Applicants respectfully submit that Cheng, et al. do not teach or suggest a method in which a structure including a second substrate and an intermediate agent layer is used and that upon bonding the intermediate agent layer forms a silicide including Ge. Applicants observe that the term "silicide" does not appear in the disclosure of Cheng, et al.

The above defects in Cheng, et al. are not alleviated by Muto, et al. and Kub '796 for the following reasons: Muto, et al. are deficient for the reasons discussed above. The applied Kub '796 reference does not teach or suggest that upon bonding the intermediate agent layer is converted into a silicide that includes Ge. Kub '796 does mention that a metal or a silicide layer may be present at the bonding interface, but there are no details in the patent as to how the layer is formed. Applicants again observe that the silicide is disclosed as an additional layer that is formed prior to bonding in Kub '796.

Kub '495 does not alleviate the above defects in the applied combination of references since it does not teach or suggest that upon bonding the intermediate agent layer is converted into a silicide that includes Ge. Kub '495 does mention a silicide layer 123 may be present at the bonding interface (see FIG 13), but the silicide is formed prior to bonding, not during bonding,

as presently claimed. Also, the reference does not indicate the presence of Ge in the metal silicide layer.

Based upon the above amendments and remarks, the obviousness rejections based on Cheng, et al., Muto, et al. and Kub '976 or Cheng, et al., Kub '976, Muto, et al. and Kub '495 have been obviated. Reconsideration and withdrawal thereof are respectfully requested.

Thus, in view of the foregoing amendments and remarks, it is firmly believed that the present case is in condition for allowance, which action is earnestly solicited.

Respectfully submitted,

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